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ABSTRACT:

PROBLEM TO BE SOLVED: To provide a **telecentric optical** system whose
magnification **color** aberration is small even when an object plane and an **image**
plane both have swing angles.

SOLUTION: The telecentric optical system has first and second optical
systems L<SB>1</SB>, L<SB>2</SB> and is an optical system in which an object
plane 9 having a swing angle θ<SB>1</SB> is arranged at the front side
focal position of the optical system L<SB>1</SB> and the

rear side focal
position of the optical system L<SB>1</SB> and the front side focal position of
the optical system L<SB>2</SB> coincide with each other and also an image plane
10 having a swing angle θ<SB>2</SB> is arranged at the rear side focal
position of the optical system L<SB>2</SB> and an incident pupil and an
outgoing pupil are both existing at infinite distant positions in a reference
wavelength. In this case, the outgoing pupil (pupil plane 20) is existing at a
position whose absolute value is spaced by a distance of not shorter than
5000mm from the crossing 13 of the image plane 10 and an optical axis to the
optical system L<SB>2</SB> side in the optical axis direction in a wavelength
which is most different from the reference wavelength among use wavelengths
including the reference wavelength.

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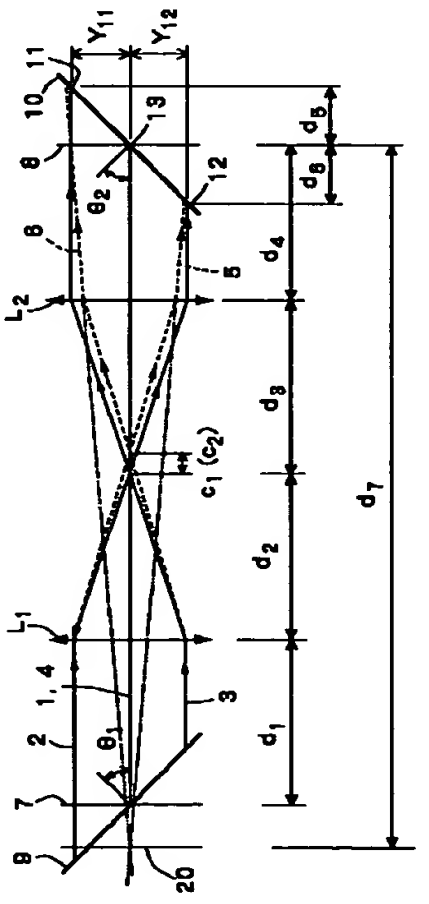
(54)【発明の名称】　テレセントリック光学系

(57)【要約】
【課題】物体面及び像面が共にアオリ角度を持つ場合でも、倍率色収差の小さいテレセントリック光学系を提供すること。
【解決手段】第１，第２の光学系L_1，L_2を有し、光学系L_1の前側焦点位置にアオリ角度θ_1を持つ物体面９が配置され、光学系L_1の後側焦点位置と光学系L_2の前側焦点位置とが合致し、かつ光学系L_2の後側焦点位置にアオリ角度θ_2を持つ像面１０が配置された光学系で、入射瞳及び射出瞳が共に基準波長で無限遠にあるテレセントリックな光学系において、射出瞳（瞳面２０）が、基準波長を含む使用波長のうち基準波長と最も異なる波長で、像面１０と光軸の交点１３から光軸方向で光学系L_2側に絶対値がほぼ５０００ｍｍ以上離れた位置にあることを特徴とするテレセントリック光学系である。



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【特許請求の範囲】
【請求項１】アオリ角度を持つ有限の物体面上の物体をアオリ角度を持つ像面に結像する光学系で、入射瞳及び射出瞳の少なくとも一方が基準波長でほぼ無限遠にあるテレセントリック光学系において、
前記入射瞳及び射出瞳の少なくとも一方が、前記基準波長を含む使用波長のうち該基準波長と最も異なる波長で、前記像面と光軸の交点から光軸方向に絶対値がほぼ５０００ｍｍ以上離れた位置にあることを特徴とするテレセントリック光学系。
【請求項２】アオリ角度のない仮想の物体面とアオリ角度のない仮想の像面との間の結像関係では、縦の色収差及び倍率色収差が補正されていることを特徴とする請求項１記載のテレセントリック光学系。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、アオリ角度を持つ有限の物体面上の物体をアオリ角度を持つ像面に結像する光学系で、入射瞳又は射出瞳の少なくとも一方が無限遠にあるテレセントリック光学系に関し、特に大きなアオリ角度を持つ半導体露光装置のオートフォーカス光学系に適用可能なテレセントリック光学系に関する。
【０００２】
【従来の技術】従来、この種のテレセントリック光学系としては、例えば図３に示すようなものが知られている。このテレセントリック光学系は、第１の光学系L_1と第２の光学系L_2とからなる。このテレセントリック光学系において、
$d_1＝d_2＝f_1$、
$d_3＝d_4＝f_2$
である。ここで、f_1は第１の光学系L_1の基準波長に対する焦点距離、f_2は第２の光学系L_2の基準波長に対する焦点距離である。すなわち、このテレセントリック光学系では、第１の光学系L_1の前側焦点位置に、光軸に垂直な物体面７ａが配置され、この光学系L_1の後側焦点位置と第２の光学系L_2の前側焦点位置とが合致するように両光学系L_1，L_2が配置され、かつ第２の光学系L_2の後側焦点位置に、光軸に垂直な像面８ａが配置されている。したがって、このテレセントリック光学系は、入射瞳及び射出瞳が共に基準波長で無限遠にある両側テレセントリックな光学系である。
【０００３】このテレセントリック光学系では、基準波長の主光線を１ａ，２ａ，３ａ、基準波長を含む使用波長のうち，基準波長と最も異なる波長の主光線を４ａ，５ａ，６ａとしたとき、第１の光学系L_1による縦の色収差C_{1a}があっても、この色収差C_{1a}を第２の光学系L_2による縦の色収差C_{2a}で打ち消せば、主光線３ａと６ａ及び主光線２ａと５ａはそれぞれ像面８ａ上でほぼ交わり、倍率色収差が小さい。
【０００４】

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【発明が解決しようとする課題】上記従来のテレセントリック光学系では、有限の物体面７ａがアオリ角度を持ちかつ像面８ａがアオリ角度を持つように構成した場合、第１の光学系L_1による縦の色収差C_{1a}を第２の光学系L_2による縦の色収差C_{2a}で打ち消しても、基準波長と最も異なる波長で、射出瞳は物体側で有限の位置にあり、アオリ角度を持つ像面上では、主光線３ａと６ａ及び主光線２ａと５ａはそれぞれ交わらず、倍率色収差が発生してしまうという問題があった。本発明は、このような従来の問題に着目してなされたもので、その課題は、物体面及び像面が共にアオリ角度を持つ場合でも、倍率色収差の小さいテレセントリック光学系を提供することである。
【０００５】
【課題を解決するための手段】上記課題を解決するため本発明は、アオリ角度を持つ有限の物体面上の物体をアオリ角度を持つ像面に結像する光学系で、入射瞳及び射出瞳の少なくとも一方が基準波長でほぼ無限遠にあるテレセントリック光学系において、入射瞳及び射出瞳の少なくとも一方が、基準波長を含む使用波長のうち基準波長と最も異なる波長で、像面と光軸の交点から光軸方向に絶対値がほぼ５０００ｍｍ以上離れた位置にあることを特徴とするテレセントリック光学系である。
【０００６】
【発明の実施の形態】次に、本発明の実施の形態を図面に基づいて説明する。図１は、本発明の一実施例に係るテレセントリック光学系を示している。このテレセントリック光学系は、第１の光学系L_1と第２の光学系L_2とからなる。この光学系において、
$d_1＝d_2＝f_1$、
$d_3＝d_4＝f_2$
である。ここで、f_1は第１の光学系L_1の基準波長に対する焦点距離、f_2は第２の光学系L_2の基準波長に対する焦点距離である。すなわち、このテレセントリック光学系では、第１の光学系L_1の前側焦点位置に物体面９が配置され、この光学系L_1の後側焦点位置と第２の光学系L_2の前側焦点位置とが合致するように両光学系L_1，L_2が配置され、かつ第２の光学系L_2の後側焦点位置に像面１０が配置されている。したがって、このテレセントリック光学系は、入射瞳及び射出瞳が共に基準波長で無限遠にある両側テレセントリックな光学系である。
【０００７】また、このテレセントリック光学系では、両光学系L_1，L_2の光軸に垂直な仮想の物体面（アオリ角度のない仮想の物体面）７と、光軸に垂直な仮想の像面（アオリ角度のない仮想の像面）８との間の結像関係について、縦の色収差及び倍率色収差が補正されている。すなわち、このテレセントリック光学系は、基準波長λ_1（例えばλ_1＝５００ｎｍ）の主光線を１，２，３とし、かつ基準波長を含む使用波長（例えば４００～7

００ｎｍ）のうち，基準波長λ_1と最も異なる波長λ_2（例えばλ_2＝７００ｎｍ）の主光線を４，５，６としたとき、第１の光学系L_1による縦の色収差C_1を第２の光学系L_2による縦の色収差C_2で打ち消すように構成されている。これによって、主光線３と６及び主光線２と５はそれぞれ仮想の像面８上でほぼ交わる。

【０００８】また、このテレセントリック光学系において、物体面９はアオリ角度θ_1を持っている。すなわち、物体面９の法線は光軸から角度θ_1だけ傾いている。一方、像面１０はアオリ角度θ_2を持っている。すなわち、像面１０の法線は光軸から角度θ_2だけ傾いている。アオリ角度θ_1とθ_2は、下記の式で表されるシャインプルーフの定理を満足している。

$$\tan\theta_2=\beta\tan\theta_1$$

ここで、βはテレセントリック光学系の倍率である。さらに、このテレセントリック光学系では、その射出瞳が、基準波長λ_1と最も異なる波長λ_2で、像面１０と光軸の交点１３から光軸方向で光学系L_2側にほぼ５０００mm離れた位置に結像するようになっている。すなわち、その交点１３から射出瞳までの距離d_7をほぼ－５０００mmにしてある。なお、符号２０は射出瞳の瞳面を示している。

【０００９】次に、上記構成を有するテレセントリック光学系において、射出瞳が、基準波長λ_1と最も異なる＊

＊波長λ_2で、交点１３から光軸方向で光学系L_2側に絶対値がほぼ５０００mm以上離れた位置に結像するように構成した根拠を、図１及び図２に基づいて説明する。図１に示すテレセントリック光学系において、例えば、交点１３から像面１０上での主光線３の像点１１までの光軸方向の距離（アオリによる距離）d_5を＋１０mm、交点１３から像面１０上での主光線２の像点１２までの光軸方向の距離（アオリによる距離）d_6を－１０mm、像高Y_{11}を＋５mm、像高Y_{12}を－５mm、倍率色収差をΔ_y（図２参照）、とすると、像点１１での許容できる倍率色収差Δ_yはほぼ＋１０μ以下であり、像点１２での許容できる倍率色収差Δ_yはほぼ－１０μ以下である。

【００１０】また、図２に示すように、主光線３と仮想の像面８の交点をａ、射出瞳の瞳面２０と光軸の交点をｂ、主光線３の延長線３Ａと瞳面２０の交点をｃ、像面１０上での主光線６の像点をｄ、像点１１を通る主光線３の延長線と像点ｄを通る光軸に垂直な線との交点をｅとすると、点ａ，ｂ，ｃを頂点とする三角形ａｂｃは点ａ，ｄ，ｅを頂点とする三角形ａｄｅとほぼ相似である。それ故、交点１３から射出瞳の瞳面２０までの距離d_7、アオリによる距離d_5、像高Y_{11}及び倍率色収差Δ_yの間で以下の関係が近似的に成立する（図２参照）。

$$d_7 : d_5 = Y_{11} : \Delta_y \quad \cdots（１）式$$

この（１）式より、

$$\Delta_y = d_5 \times Y_{11} / d_7 \quad \cdots（２）式$$

が得られる。

※以下であるので、上記（２）式より、

【００１１】許容できる倍率色収差Δ_yはほぼ＋１０μ ※

$$\Delta_y = d_5 \times Y_{11} / d_7 \leqq 10\mu \quad \cdots（３）式$$

が得られる。（３）式のΔ_y，d_5，Y_{11}に１０μ，１０mm，５mmをそれぞれ代入すると、$d_7 \geqq 5000$mmが得られる。

【００１２】このように、上記実施例によれば、射出瞳が、基準波長λ_1と最も異なる波長λ_2で、交点１３から光軸方向で光学系L_2側にほぼ５０００mm離れた位置に結像するように構成されているので、像点１１での倍率色収差Δ_yがほぼ＋１０μ以下となり、かつ像点１２での倍率色収差Δ_yがほぼ－１０μ以下となる。したがって、物体面９及び像面１０が共にアオリ角度θ_1及びθ_2を持つ場合でも、倍率色収差Δ_yの小さいテレセントリック光学系が得られる。

【００１３】なお、上記実施例では、射出瞳は交点１３より光学系L_2側にあり、交点１３から射出瞳の瞳面２０までの距離d_7をほぼ－５０００mmにしてあるが、本発明はこれに限定されない。例えば、射出瞳が波長λ_2で、交点１３から光軸方向で光学系L_2とは反対側にほぼ５０００mm離れた位置に結像するようにすればよい。すなわち、距離d_7をほぼ＋５０００mmにすればよい。

★【００１４】結局、この発明に係るテレセントリック光学系では、射出瞳が、基準波長λ_1と最も異なる波長λ_2で、交点１３から光軸方向に絶対値がほぼ５０００mm以上離れた位置に結像するように、構成すればよい。また、上記実施例では、両側テレセントリックな光学系について説明したが、本発明は、入射瞳及び射出瞳のいずれか一方が基準波長でほぼ無限遠にある片側テレセントリックな光学系にも適用できる。

【００１５】

【実施例】本発明の実施例を図４を用いて説明する。これは、半導体露光装置の焦点位置計測装置である。図示しない照明系からの光が、レチクル２１の像をウエハ２２へ縮小投影レンズ２３を介して結像する。このウエハの焦点位置を斜めからウエハへ光を入射し、反射した光の像の位置ずれより検出する。ここで、スリット２７とウエハ２２、像面３２はアオリの関係を満たしており、ウエハの面位置を計測できる。ファイバ２４からの光は、照明系２５でプリズム２６の表面にパターニングされたスリット２７を照明する。前記プリズム２６はスリット２７上でのアオリ角度を低減することができる。ス

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リット２７を出た光は、レンズ系２８、２９を通り、ウエハ２２上へ結像され、反射される。反射光は、レンズ系３０、３１を通り、受光面３２上へ結像する。プリズム３３によりアオリ角度を低減され、レンズ系３４を介し、ＣＣＤ３５上へ結像される。該ＣＣＤ３５によりスリット２７の像の位置ずれを検出する。レンズ系２８、２９及び３０、３１は入射瞳及び射出瞳が基準波長を含む使用波長のうち基準波長と最も異なる波長で、像面と光軸の交点から光軸方向に絶対値が５０００ｍｍ以上離れた位置にある両側テレセントリック光学系である。

【００１６】ここで、広帯域の光源を用い、レンズ系２８、２９、３０、３１に倍率色収差がある場合、ウエハ２２上のレジスト厚が変化した場合、多重干渉により波長が選択され、ビームの光重心が移動する。このためビームの横ずれを検出する本焦点位置検出装置において検出誤差になる。

【００１７】次に第２の実施例を図５を用いて説明する。これは、光電顕微鏡の原理を用いた焦点位置検出装置である。送光スリット２７と受光スリット３２は、ほぼ等しい幅を有し、ＣＣＤ３５にかえてフォトダイオードなどのセンサ４０となる。また、新たに振動ミラー４１が追加され、受光スリット３２上でビームを振動させる他は、前記第１の実施例と基本的に同じである。

【００１８】この場合もレンズ系２８、２９及び３０、３１は入射瞳及び射出瞳が基準波長を含む使用波長のうち基準波長と最も異なる波長で、像面と光軸の交点から光軸方向に絶対値が５０００ｍｍ以上離れた位置にある両側テレセントリック光学系である。倍率色収差が大きいと検出誤差となるのは、第１の実施例と同様である。

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【００１９】

【発明の効果】以上説明したように、本発明によれば、物体面及び像面が共にアオリ角度を持つ場合でも、倍率色収差を小さくすることができる。

【図面の簡単な説明】

【図１】本発明の一実施例に係るテレセントリック光学系を示す概略構成図

【図２】一実施例に係るテレセントリック光学系についての説明図

【図３】従来のテレセントリック光学系を示す概略構成図

【図４】画像処理型の焦点位置検出装置

【図５】光電顕微鏡型の焦点位置検出装置

【符号の説明】

１，２，３…基準波長の主光線

４，５，６…基準波長と異なる波長の主光線

７…仮想の物体面　　８…仮想の像面

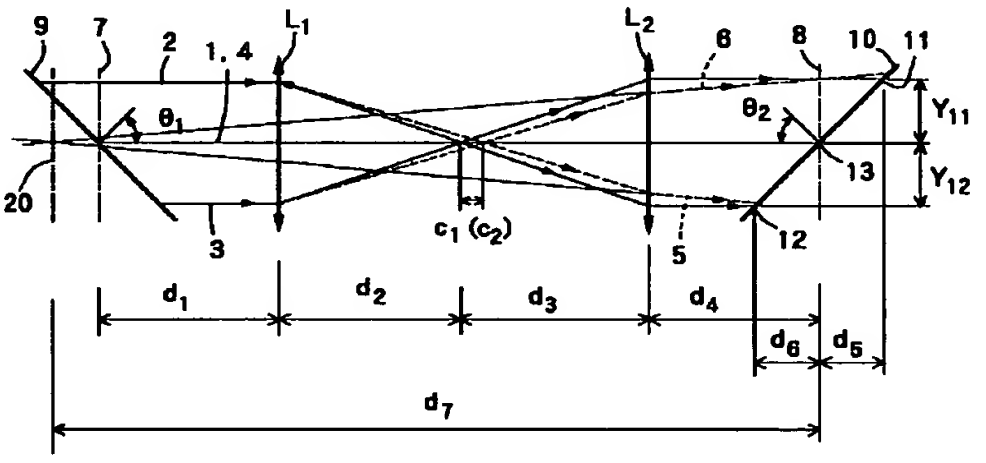
９…アオリ角度を持つ物体面　　１０…アオリ角度を持つ像面

１１，１２…像点　　２０…射出瞳の瞳面

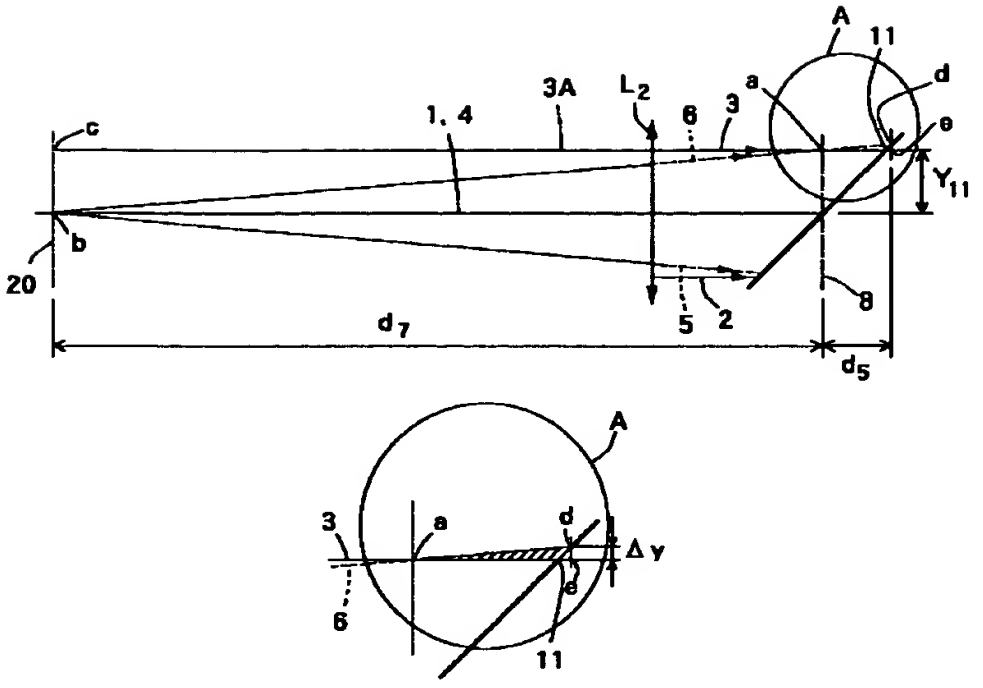
L_1…第１の光学系　　L_2…第２の光学系

θ_1，θ_2…アオリ角度と光軸の交点　　１３…像面

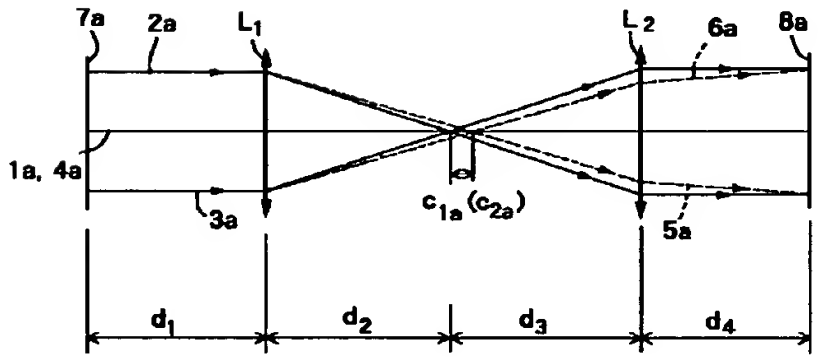
【図１】



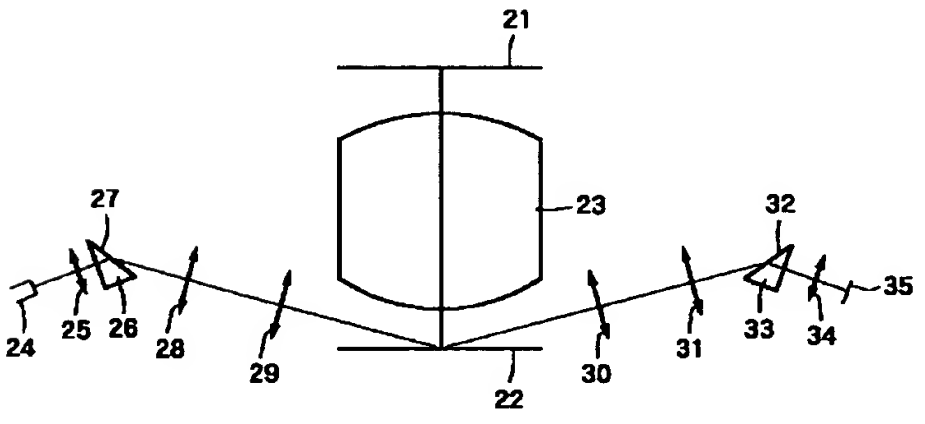
【図2】


A
11
d
e
a
3A
L_2
1, 4
6
3
c
b
20
Y_{11}
8
5
2
d_7
d_5
A
3
a
d
Δy
e
6
11

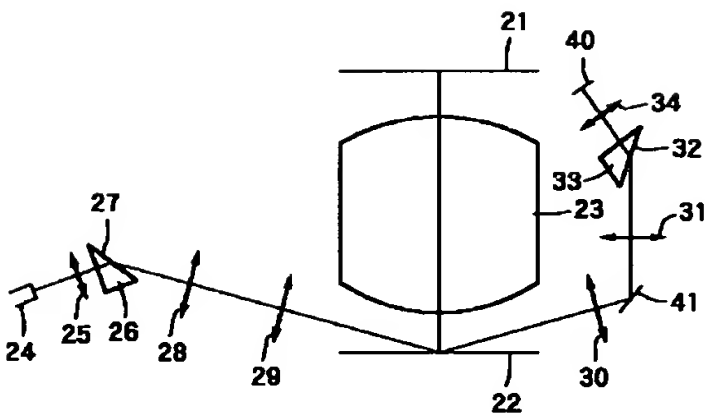
【図3】


7a
2a
L_1
L_2
6a
8a
1a, 4a
3a
$c_{1a}(c_{2a})$
5a
d_1
d_2
d_3
d_4

【図4】


21
27
23
32
35
24
25
26
28
29
30
31
33
34
22

【図5】



PATENT ABSTRACTS OF JAPAN

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(54) TELECENTRIC OPTICAL SYSTEM

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a telecentric optical system whose magnification color aberration is small even when an object plane and an image plane both have swing angles.
SOLUTION: The telecentric optical system has first and second optical systems L1, L2 and is an optical system in which an object plane 9 having a swing angle θ1 is arranged at the front side focal position of the optical system L1 and the rear side focal position of the optical system L1 and the front side focal position of the optical system L2 coincide with each other and also an image plane 10 having a swing angle θ2 is arranged at the rear side focal position of the optical system L2 and an incident pupil and an outgoing pupil are both existing at infinite distant positions in a reference wavelength. In this case, the outgoing pupil (pupil plane 20) is existing at a position whose absolute value is spaced by a distance of not shorter than 5000mm from the crossing 13 of the image plane 10 and an optical axis to the optical system L2 side in the optical axis direction in a wavelength which is most different from the reference wavelength among use wavelengths including the reference wavelength.

LEGAL STATUS

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[Date of registration]

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[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

CLAIMS

[Claim(s)]
[Claim 1] By the optical system which carries out image formation of the body on the body side of finite with a swing-and-tilt include angle to the image surface with a swing-and-tilt include angle In the telecentric optical system which has mostly either [at least] an entrance pupil or an exit pupil in infinite distance on criteria wavelength, on this criteria wavelength and most different wavelength among the operating wavelength in which either [at least] said entrance pupil or an exit pupil contains said criteria wavelength Telecentric optical system characterized by being in the location which the absolute value separated from the intersection of said image surface and optical axis about 5000mm or more in the direction of an optical axis.
[Claim 2] Telecentric optical system according to claim 1 characterized by amending vertical chromatic aberration and the vertical chromatic aberration of magnification in the image formation relation between the body side of imagination without a swing-and-tilt include angle, and the image surface of imagination without a swing-and-tilt include angle.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention is the optical system which carries out image formation of the body on the body side of finite with a swing-and-tilt include angle to the image surface with a swing-and-tilt include angle, and relates to telecentric optical system applicable to the automatic focus optical system of the semi-conductor aligner which has a big swing-and-tilt include angle especially about the telecentric optical system which has either [at least] an entrance pupil or an exit pupil in infinite distance.
[0002]
[Description of the Prior Art] Conventionally, as this kind of telecentric optical system, the thing as shown, for example in drawing 3 is known. This telecentric optical system consists of the 1st optical system L1 and 2nd optical system L2. In this telecentric optical system, it is d1=d2=f1 and d3=d4=f2. Here, a focal distance [as opposed to the criteria wavelength of the 1st optical system L1 in f1] and f2 are the focal distances to the criteria wavelength of the 2nd optical system L2. That is, in this telecentric optical system, body side 7a perpendicular to an optical axis is arranged in a before [the 1st optical system L1] side focal location, both the optical system L1 and L2 is arranged, and image surface 8a perpendicular to an optical axis is arranged in the backside [the 2nd optical system L2] focal location so that a backside [this optical system L1] focal location and a before [the 2nd optical system L2] side focal location may agree. therefore, the both-sides tele cent to which this telecentric optical system has [both] an entrance pupil and an exit pupil in infinite distance on criteria wavelength -- it is rucksack optical system.
[0003] When the chief ray of wavelength which is most different from the criteria wavelength among the operating wavelength containing 1a, 2a, 3a, and criteria wavelength in the chief ray of criteria wavelength is set to 4a, 5a, and 6a in this telecentric optical system, If this chromatic-aberration C1a is negated by chromatic-aberration C2a of the length by the 2nd optical system L2 even if there is chromatic-aberration C1a of the length by the 1st optical system L1, chief rays 3a and 6a and chief rays 2a and 5a have an intersection and the almost small chromatic aberration of magnification on image surface 8a respectively.
[0004]
[Problem(s) to be Solved by the Invention] When body side 7a of finite consists of above-mentioned conventional telecentric optical system with a swing-and-tilt include angle so that image surface 8a may have a swing-and-tilt include angle, Even if it negates chromatic-aberration C1a of the length by the 1st optical system L1 by chromatic-aberration C2a of the length by the 2nd optical system L2, on criteria wavelength and most different wavelength The exit pupil was in the location of finite by the body side, and on the image surface with a swing-and-tilt include angle, chief rays 3a and 6a and chief rays 2a and 5a did not cross, respectively, but had the problem that the chromatic aberration of magnification will break out. This invention was made paying attention to such a conventional problem, and the technical problem is [both] offering the small telecentric optical system of the chromatic aberration of magnification, even when a body side and the image surface have a swing-and-tilt include angle.
[0005]
[Means for Solving the Problem] In order to solve the above-mentioned technical problem, this invention is the optical system which carries out image formation of the body on the body side of finite with a

swing-and-tilt include angle to the image surface with a swing-and-tilt include angle. In the telecentric optical system which has mostly either [at least] an entrance pupil or an exit pupil in infinite distance on criteria wavelength, on criteria wavelength and most different wavelength among the operating wavelength in which either [at least] an entrance pupil or an exit pupil contains criteria wavelength It is the telecentric optical system characterized by being in the location which the absolute value separated from the intersection of the image surface and an optical axis about 5000mm or more in the direction of an optical axis.

[0006]

[Embodiment of the Invention] Next, the gestalt of operation of this invention is explained based on a drawing. Drawing 1 shows the telecentric optical system concerning one example of this invention. This telecentric optical system consists of the 1st optical system L1 and 2nd optical system L2. In this optical system, it is d1=d2=f1 and d3=d4=f2. Here, a focal distance [as opposed to the criteria wavelength of the 1st optical system L1 in f1] and f2 are the focal distances to the criteria wavelength of the 2nd optical system L2. That is, in this telecentric optical system, the body side 9 is arranged in a before [the 1st optical system L1] side focal location, both the optical system L1 and L2 is arranged so that a backside [this optical system L1] focal location and a before [the 2nd optical system L2] side focal location may agree, and the image surface 10 is arranged in the backside [the 2nd optical system L2] focal location. therefore, the both-sides tele cent to which this telecentric optical system has [both] an entrance pupil and an exit pupil in infinite distance on criteria wavelength -- it is rucksack optical system.

[0007] Moreover, in this telecentric optical system, vertical chromatic aberration and the vertical chromatic aberration of magnification are amended about the image formation relation between the body side (body side of imagination without a swing-and-tilt include angle) 7 of imagination perpendicular to the optical axis of both the optical system L1 and L2, and the image surface (image surface of imagination without a swing-and-tilt include angle) 8 of imagination perpendicular to an optical axis. Namely, this telecentric optical system sets the chief ray of the criteria wavelength lambda 1 (for example, lambda1=500nm) to 1, 2, and 3. And when the chief ray of the criteria wavelength lambda 1 and most different wavelength lambda 2 (for example, lambda2=700nm) is set to 4, 5, and 6 among the operating wavelength (for example, 400-700nm) containing criteria wavelength, It is constituted so that the chromatic aberration C1 of the length by the 1st optical system L1 may be negated by the chromatic aberration C2 of the length by the 2nd optical system L2. By this, chief rays 3 and 6 and chief rays 2 and 5 cross mostly on the image surface 8 of imagination, respectively.

[0008] Moreover, in this telecentric optical system, the body side 9 has the swing-and-tilt include angle theta 1. Namely, as for the normal of the body side 9, only the include angle theta 1 leans from the optical axis. On the other hand, the image surface 10 has the swing-and-tilt include angle theta 2. Namely, as for the normal of the image surface 10, only the include angle theta 2 leans from the optical axis. The swing-and-tilt include angles theta1 and theta2 have satisfied the theorem of the Shine proof expressed with the following formula.

tantheta2=betatantheta1 -- here, beta is the scale factor of telecentric optical system. Furthermore, according to this telecentric optical system, that exit pupil carries out image formation to the location separated from the intersection 13 of the image surface 10 and an optical axis about 5000mm to the optical-system L2 side in the direction of an optical axis on the criteria wavelength lambda 1 and most different wavelength lambda 2. That is, it is [about] about the distance d7 from the intersection 13 to an exit pupil. -It is made 5000mm. In addition, the sign 20 shows the pupil surface of an exit pupil.

[0009] Next, in the telecentric optical system which has the above-mentioned configuration, an exit pupil explains the basis constituted so that image formation might be carried out to the location which the absolute value separated from the intersection 13 about 5000mm or more to the optical-system L2 side in the direction of an optical axis on the criteria wavelength lambda 1 and most different wavelength lambda 2 based on drawing 1 and drawing 2 . It sets to the telecentric optical system shown in drawing 1 . The distance (distance by swing and tilt) d5 of the direction of an optical axis from the intersection 13 to the image point 11 of the chief ray 3 on the image surface 10 +10mm, If +5mm and the image quantity Y12 are

set to -5mm and the chromatic aberration of magnification is set to deltay (refer to drawing 2) for -10mm and the image quantity Y11, the distance (distance by swing and tilt) d6 of the direction of an optical axis from the intersection 13 to the image point 12 of the chief ray 2 on the image surface 10 Permissible chromatic-aberration-of-magnification deltay in the image point 11 is about +10micro or less, and permissible chromatic-aberration-of-magnification deltay in the image point 12 is [about]. -It is 10micro or less.

[0010] As shown in drawing 2 , the pupil surface 20 of a and an exit pupil, and the intersection of an optical axis for the intersection of the image surface 8 of a chief ray 3 and imagination Moreover, b, If the intersection of production 3A of a chief ray 3, the production of the chief ray 3 which passes the image point of the chief ray 6 on c and the image surface 10 along d and the image point 11 for the intersection of a pupil surface 20, and a line perpendicular to the optical axis which passes along the image point d is set to e The triangle abc which makes Points a, b, and c top-most vertices is similarity mostly with the triangle ade which makes Points a, d, and e top-most vertices. So, the relation of the following [between the distance d7 from the intersection 13 to the pupil surface 20 of an exit pupil, the distance d5 by swing and tilt, the image quantity Y11, and chromatic-aberration-of-magnification deltay] is materialized in approximation (refer to drawing 2).

d7: d5=Y11:deltay -- (1) type of (1) type ** deltay=d5xY11/d7 -- (2) A formula is obtained.

[0011] Since it is about +10micro or less, permissible chromatic-aberration-of-magnification deltay is the above-mentioned (2) formula. deltay=d5xY11/d7 <=10micro -- (3) A formula is obtained. (3) If 10micro, 10mm, and 5mm are substituted for delta y, d5, and Y11 of a formula, respectively, d7 >=5000mm will be obtained.

[0012] Thus, since according to the above-mentioned example the exit pupil consists of criteria wavelength lambda 1 and most different wavelength lambda 2 so that image formation may be carried out to the location separated from the intersection 13 about 5000mm to the optical-system L2 side in the direction of an optical axis, chromatic-aberration-of-magnification deltay in the image point 11 is set to about +10micro or less, and chromatic-aberration-of-magnification deltay in the image point 12 is [about]. -It is set to 10micro or less. Therefore, even when both the body side 9 and the image surface 10 have the swing-and-tilt include angles theta1 and theta2, the small telecentric optical system of chromatic-aberration-of-magnification deltay is acquired.

[0013] In addition, in the above-mentioned example, an exit pupil is in an optical-system L2 side from an intersection 13, and it is [about] about the distance d7 from the intersection 13 to the pupil surface 20 of an exit pupil. -Although it is made 5000mm, this invention is not limited to this. For example, an exit pupil should be made just to carry out image formation on wavelength lambda 2 in the location left about 5000mm to the opposite side to optical system L2 in the direction of an optical axis from an intersection 13. Namely, what is necessary is just to set distance d7 to about +5000mm.

[0014] After all, according to the telecentric optical system concerning this invention, an exit pupil should just consist of criteria wavelength lambda 1 and most different wavelength lambda 2 so that image formation may be carried out to the location which the absolute value separated from the intersection 13 about 5000mm or more in the direction of an optical axis. moreover -- the above-mentioned example -- a both-sides tele cent -- the single-sided tele cent to which this invention has either an entrance pupil and an exit pupil in infinite distance mostly on criteria wavelength although rucksack optical system was explained -- it is applicable also to rucksack optical system.

[0015]

[Example] The example of this invention is explained using drawing 4 . This is the focal location metering device of a semi-conductor aligner. The light from the illumination system which is not illustrated carries out image formation of the image of a reticle 21 through the contraction projection lens 23 to a wafer 22. Incidence of the light is carried out from across to a wafer, and the focal location of this wafer is detected from a location gap of the reflected image of light. Here, a slit 27, a wafer 22, and the image surface 32 are filling the relation of swing and tilt, and can measure the field location of a wafer. The light from a fiber 24 illuminates the slit 27 by which patterning was carried out to the front face of prism 26 by the illumination

system 25. Said prism 26 can reduce the swing-and-tilt include angle on a slit 27. The light which came out of the slit 27 passes along lens systems 28 and 29, and image formation of it is carried out and it is reflected in up to a wafer 22. The reflected light passes along lens systems 30 and 31, and they carry out image formation to up to the light-receiving side 32. A swing-and-tilt include angle is reduced with prism 33, and image formation is carried out on CCD35 through a lens system 34. This CCD35 detects a location gap of the image of a slit 27. Lens systems 28 and 29, and 30 and 31 are criteria wavelength and most different wavelength among the operating wavelength in which an entrance pupil and an exit pupil contain criteria wavelength, and they are the image surface and the both-sides telecentric optical system in the location which the absolute value separated from the intersection of an optical axis 5000mm or more in the direction of an optical axis.

[0016] Here, when the chromatic aberration of magnification is in lens systems 28, 29, 30, and 31 using the light source of a broadband and the resist thickness on a wafer 22 changes, wavelength is chosen by multiplex interference and the Mitsushige alignment of a beam moves. For this reason, in this focal location detection equipment which detects the strike slip of a beam, it becomes a detection error.

[0017] Next, the 2nd example is explained using drawing 5 . This is focal location detection equipment which used the principle of a photo electric microscope. The light transmission slit 27 and the light-receiving slit 32 have almost equal width of face, change it to CCD35, and serve as the sensors 40, such as a photodiode. Moreover, the oscillating mirror 41 is newly added, and a beam is vibrated on the light-receiving slit 32, and also it is fundamentally [as said 1st example] the same.

[0018] It is the both-sides telecentric optical system as for which lens systems 28 and 29, and 30 and 31 are criteria wavelength and most different wavelength among the operating wavelength in which an entrance pupil and an exit pupil contain criteria wavelength and which is in the location which the absolute value separated from the intersection of the image surface and an optical axis 5000mm or more in the direction of an optical axis also in this case. It is the same as that of the 1st example to become a detection error if the chromatic aberration of magnification is large.

[0019]

[Effect of the Invention] As explained above, even when both a body side and the image surface have a swing-and-tilt include angle according to this invention, the chromatic aberration of magnification can be made small.

[Translation done.]